SDG&E EPIC Overview and Highlights of Two DER Integration Projects

SDG&E Team

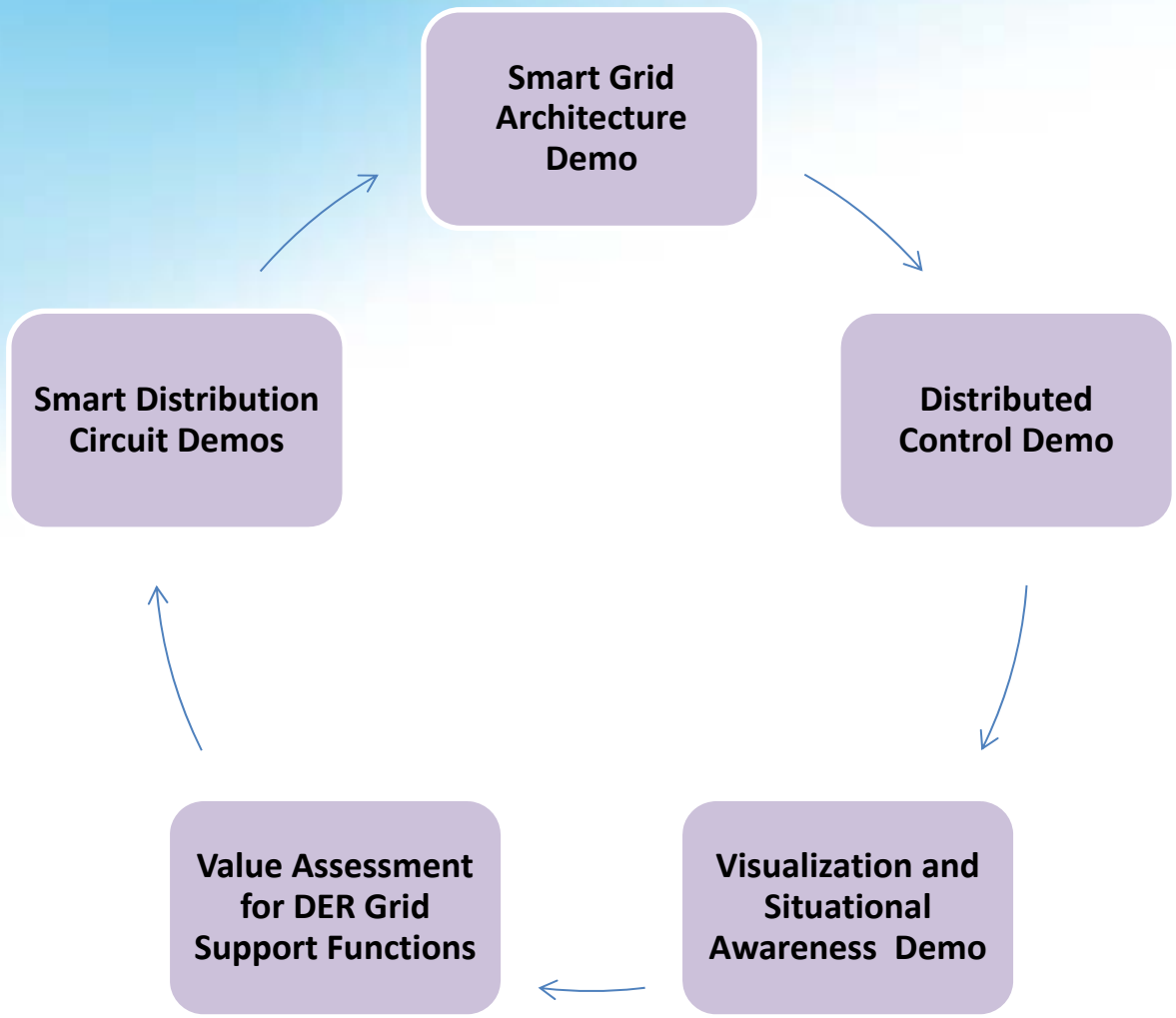
EPIC Public Stakeholder Workshop
August 18, 2015

Presentation Overview

- **Overview of SDG&E EPIC Program (Frank Goodman)—5 minutes**

- **Two Project Examples from First EPIC Triennial Cycle Program—20 minutes each**
  - **Demonstration of Grid Support Functions of Distributed Energy Resources (Kelvin Ellis)**
  - **Smart Distribution Circuit Demonstrations (Frank Goodman for John Holmes)**

SDG&E Tri-1 Plan: Five Advanced Distribution Automation Projects



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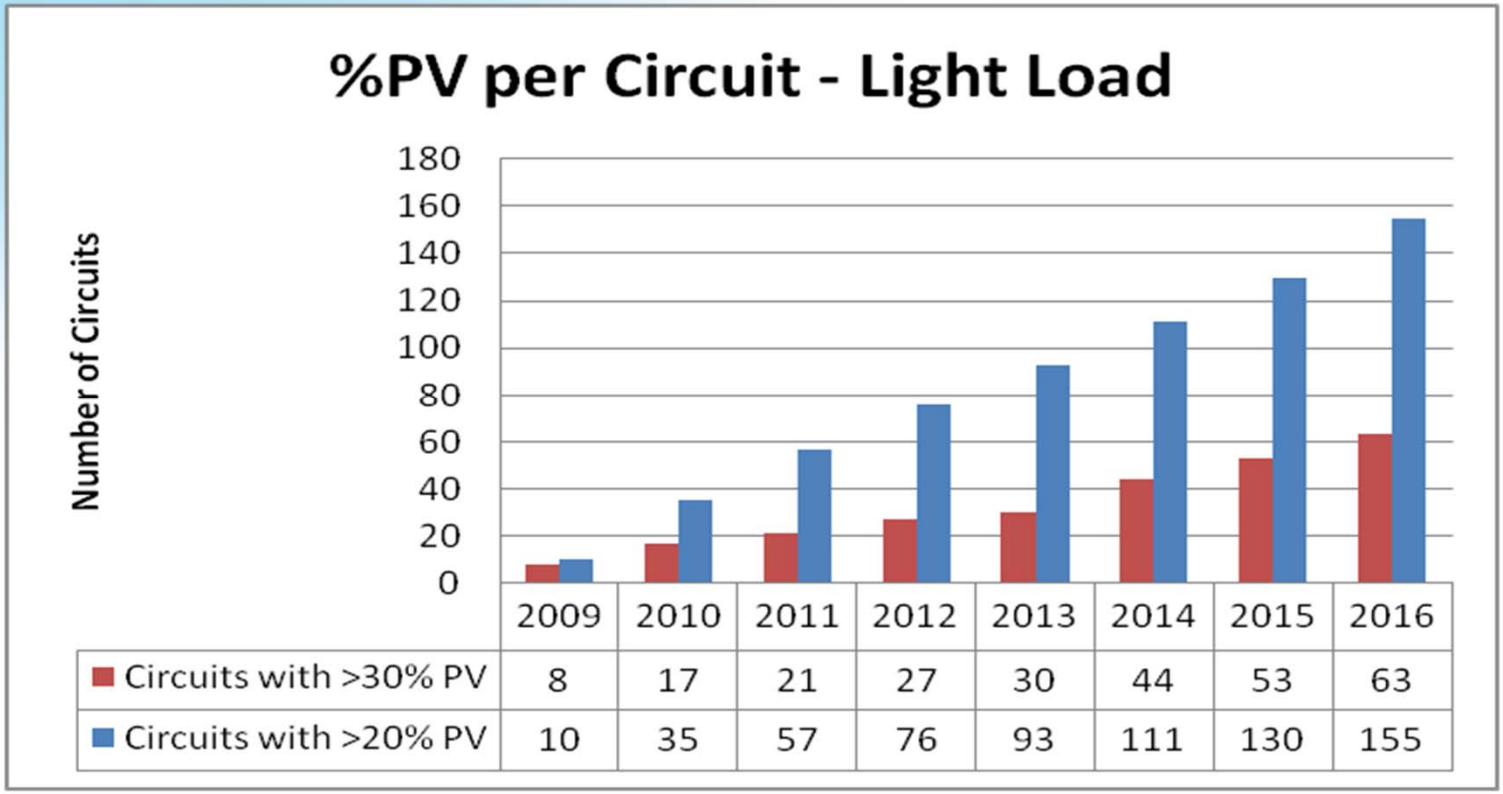
Workshop Theme is DER Integration

High DER Penetration Levels Increase the Complexity of Integrating DER and Other New Technology Options into Utility Infrastructure and Operations



	2009	2010	2011	2012	2013	2014	2015	2016
Circuits with >30% PV	8	17	21	27	30	44	53	63
Circuits with >20% PV	10	35	57	76	93	111	130	155

Status of SDG&E Tri-1 EPIC Projects

Grid Modernization and Optimization

Area of IOU Project Coordination Framework

Advanced distribution automation demonstration programs

- ***Smart distribution circuit*** — Released
- ***DER grid support functions*** — Released

Highlighted Today

- ***Distributed control*** — Partially Released*
- ***Smart grid architecture demonstrations*** — Unreleased*
- ***Visualization and situational awareness system*** — Unreleased*

***Unreleased items are on hold pending a CPUC decision regarding redirection of the funds to a separately ordered PEV Submetering Project.**

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Maximizing Ratepayer Value

EPIC pre-commercial demonstrations should be used to:

- **Create knowledge to aid in making informed technology choices**
- **Inform commercialization and deployment programs to reduce their costs and improve their results**
- **Use the small EPIC allotments to favorably impact larger, more costly programs**

Rationale used in SDG&E cost/benefit analysis for Tri-1 application

SDG&E Tri-2 EPIC Projects by Area of Coordination Framework

Renewables and Distributed Energy Resources Integration	Grid Modernization and Optimization	Customer Focused Products and Services
• *Modernization of Distribution System and Integration of Distributed Generation and Storage*	• *Data Analytics in Support of Advanced Planning and System Operations* • *Monitoring, Communication, and Control Infrastructure for Power System Modernization* • *System Operations Development and Advancement*	• *Integration of Customer Systems into Electric Utility Infrastructure*

Cross-Cutting / Foundational Strategies & Technologies

- *Collaborative Institute RD&D Programs*

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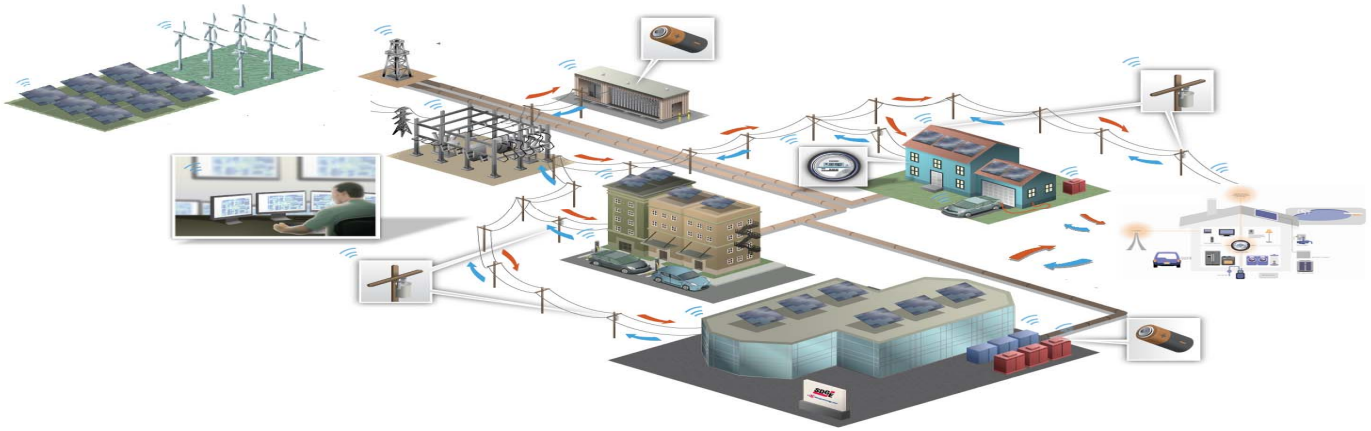
Pre-Commercial Demonstrations at SDG&E

- **Technology and integration solutions tested under controlled conditions in laboratory or field test beds, such as**
  - **SDG&E Integrated Test Facility (ITF)**
  - **Borrego Springs Microgrid**

- **Safety is foremost consideration**

- **Minimizing customer service disturbances during testing is another key consideration**



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First Highlighted Project for DER Integration Theme

Demonstration of Grid Support Functions of Distributed Energy Resources

Kelvin Ellis

Project Technical Lead

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Value Assessment of DER Grid Support Functions
Project Objectives

- **To assess the viability of specific DER functions (such as Volt/VAR regulation, providing fast response emergency power, peak shaving, and system monitoring) and to identify which grid support functions of DER and application situations should be pursued in commercial distribution system development.**
- **To clarify which existing standards would help meet the needs of future DER integration systems, and what new standards, rules and regulations are needed to facilitate the grid support DER functions in power distribution systems.**

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DER Grid Support Value Assessment
Approach

- Determine grid support functions' requirements for interconnection, interoperability and communication standards.
- Establish capabilities for control and dispatch of specific grid support functions.
- Focus testing in SDG&E's Integrated Test Facility (ITF) for cost efficiency.
- Use circuit simulations on RTDS and hardware-in-the-loop testing.
- Test DER grid support functions.
- Analyze test results to assess value of grid support functions in specific application situations.

DER Grid Support Value Assessment
Project Team

SDG&E Technical Lead
Kelvin Ellis

SDG&E Technical Staff
Steven Prsha
&
Marvin Zavala-Iraheta

Contractor
Schweitzer Engineering
Laboratories

ITF Staff

DER Grid Support Value Assessment
Challenges and Opportunities

- **Integration of DER grid support functions into power distribution systems.**
- **Coordination of DER with other controllable devices.**
- **Use of DER as a component of Volt/VAR optimization strategies.**
- **Use of DER to support intentional islanding of distribution circuits (aka microgrids)**
- **Use of DER as an emergency power source.**
- **Use of DER as a peaking power source.**
- **Trial use of emerging DER interconnection standards.**

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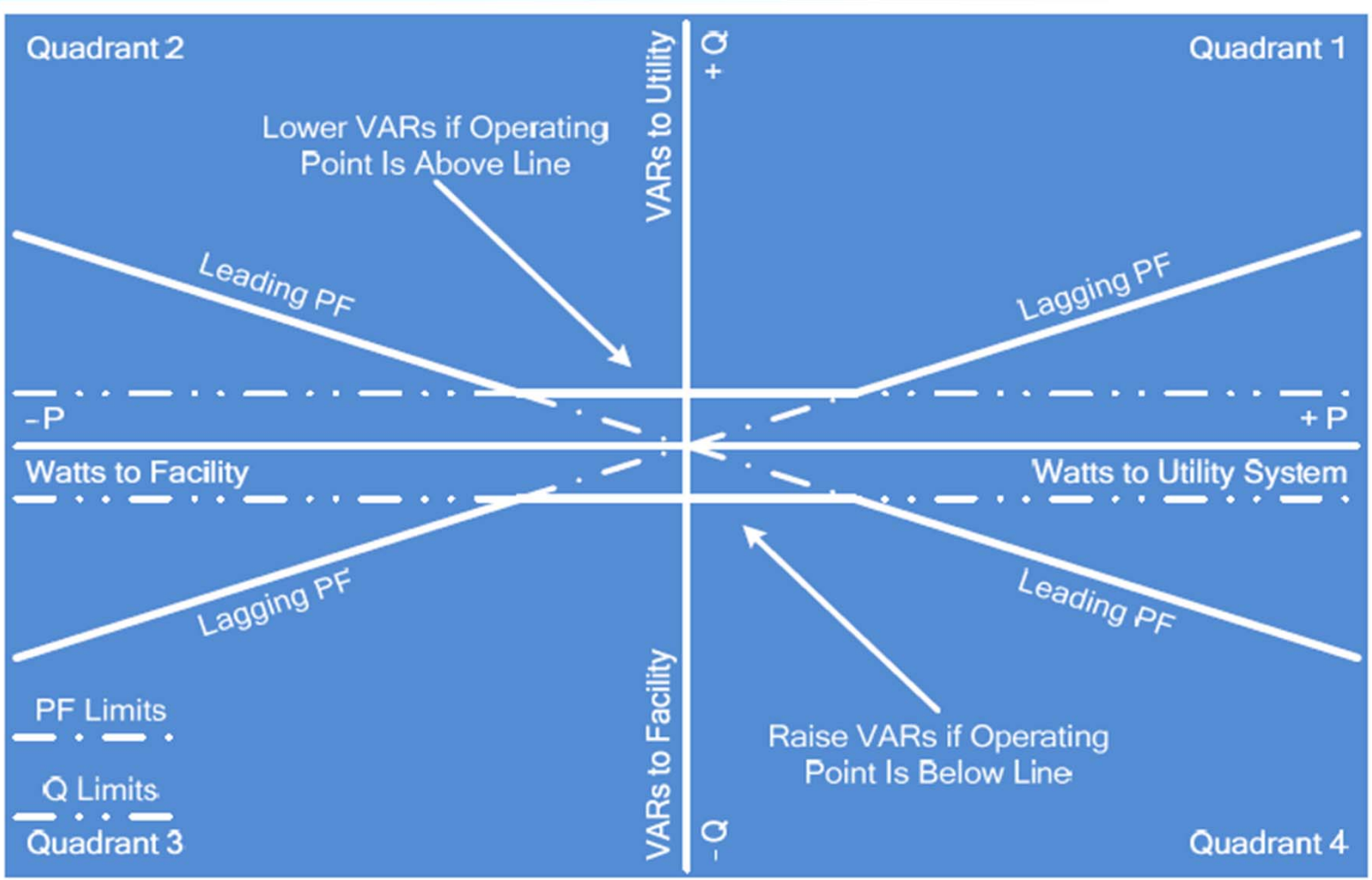
DER Grid Support Value Assessment
Example Test Cases

- The generation or absorption of reactive power.
- The detection of voltage and frequency and the ability to react autonomously.
- In combination with a communication link, to deliver real and reactive power and to charge and discharge storage facilities.
- Delivery of power in four quadrants.

DER Grid Support Value Assessment
Pilot Test Examples

Four Quadrant Inverter Operation



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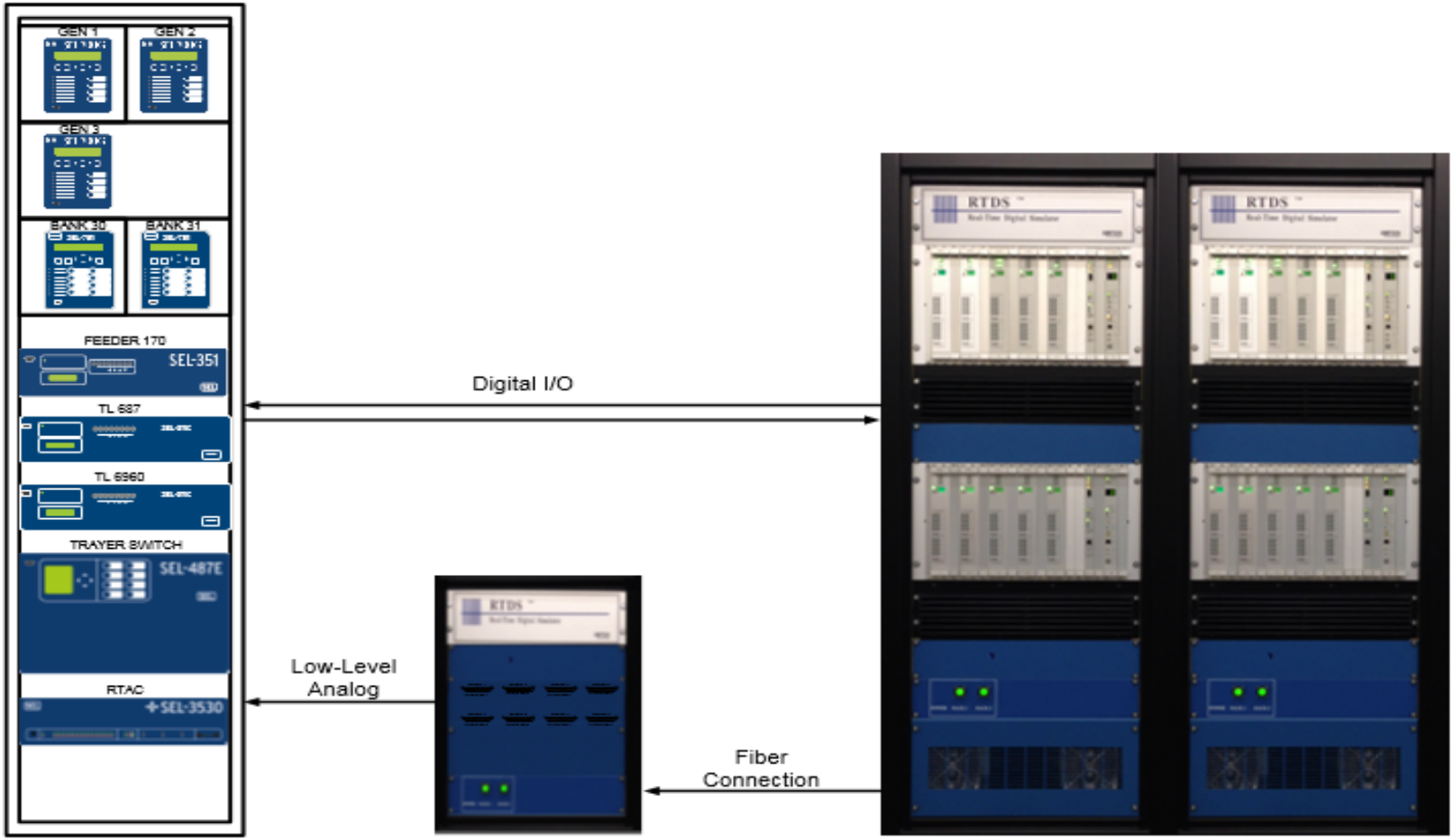
DER Grid Support Value Assessment
Test Bed Set-Up

RTDS Grid Simulation Set-Up



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DER Grid Support Value Assessment
Testing Examples

Examples of Operating Modes to be Tested:

- **Standby Mode and Anti-Islanding in Standby Mode**
- **Parallel Mode and Anti-Islanding in Parallel Mode**
- **Islanding and Resynchronization**
- **Emergency Operation Mode**

Value Assessment of DER Grid Support Functions
Deliverables

- **Milestone reports on project phases**
- **Technology transfer plan**
- **Required EPIC interim reports**
- **Final report describing work completed and all important results**

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Value Assessment of DER Grid Support Functions

Status and Schedule

- Contract awarded to Schweitzer Engineering Laboratories (SEL) in June 2015
- Detailed scope of work being developed jointly with SEL and SDG&E stakeholders
- Project planning will coordinate testing schedule with ITF team
- Work will be completed in 2017 to meet EPIC requirements

Phase	Duration
1 – Selection of functions, host sites and development of test plans	August 2015 – January 2016
2 – Setup and perform testing for specific functions in specific application situations	January 2016 – December 2016
3 – Perform analysis and final report writing. Transfer results in practice.	January 2017 – June 2017

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Second Highlighted Project for DER Integration Theme

Smart Distribution Circuit Demonstrations

John Holmes

Project Technical Lead

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Smart Distribution Circuit Demonstrations

Project Objective

To identify best practices for adopting new distribution technologies, integration and operation strategies, communication protocols, and software into more fully automated future distribution circuits by performing a series of "pre-commercial demonstrations" of alternative solutions

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Smart Distribution Circuit Demonstrations
Challenges & Opportunities

- **New electrical/electronic components, communication protocol options, and integration strategies are continually emerging for application in distribution systems**
- **Best practices are needed for robust distribution circuit designs that can assimilate new distribution system features in advanced, networked distribution system automation**

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Smart Distribution Circuit Demonstrations

Scope

- Demonstrate evolutionary distribution circuit features in simulated distribution circuits
- Features to be examined include
  - Fault location and anticipation
  - Communication protocols
  - Power electronic components
  - CVR practices
  - Voltage regulation equipment
  - Strategic use of DER
- Analyze test results and identify best practices for robust distribution circuit design and networked automation
- Maximize the benefits derived from the emerging technology, software, and integration strategies

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Smart Distribution Circuit Demonstrations
Approach

- **Market assessment of existing emerging distribution equipment, systems and operating methods**
- **Create roster of recommended solutions and define an implementation plan for trials in SDG&E's ITF using RTDS simulation**
- **Conduct RTDS simulations which accommodate legacy and new technologies**
- **Validate operational scenarios in lab, where possible, and in the field if necessary**
- **Deliver comprehensive recommendations and best practice documentation which consolidates the project results**
- **Document results and work with SDG&E stakeholders to facilitate integration of the results into standard practice**

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Smart Distribution Circuit Demonstrations
Project Team

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Contractor
Schweitzer Engineering Laboratories

ITF Staff

Smart Distribution Circuit Demonstrations
New Technology Options

- **Advanced relay & system protection devices and processes**
- **Integration of PMUs and PMU-enabled solutions**
- **Automated power electronic control devices**
  - **DVR, DVC**
  - **Phase Balancing**
  - **Dynamic Volt/VAr control**
- **DER integration**
  - **Automated multi-function DER operation**
- **'Islandability' of circuits and other new reconfiguring options**

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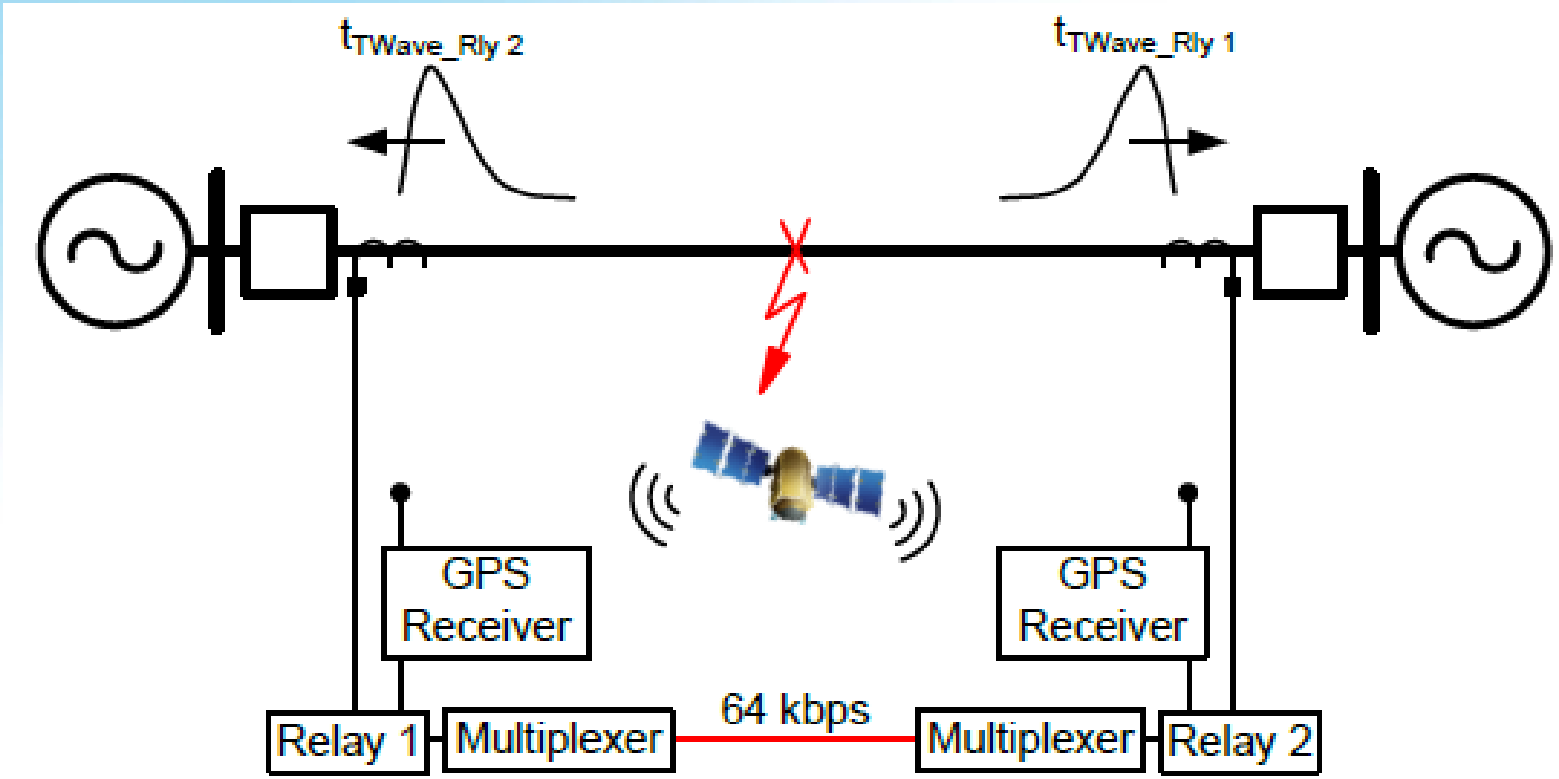
Smart Distribution Circuit Demonstrations
New Methods

- **Improving power quality & decreasing electrical losses**
- **Conservation Voltage Reduction (CVR) evolution**
- **Improved automation capabilities through network management system**
    - **Automated DER functions (e.g. 4Q operation, islanding)**
    - **Automated circuit reconfiguring**
    - **SCADA control applications**
- **Pilots of standards, e.g., IEC 61850 and its engineering tools**
- **Cyber-security & communications infrastructure**

Smart Distribution Circuit Demonstrations

Travelling Wave Fault Location



Source: Schweitzer Engineering Laboratories

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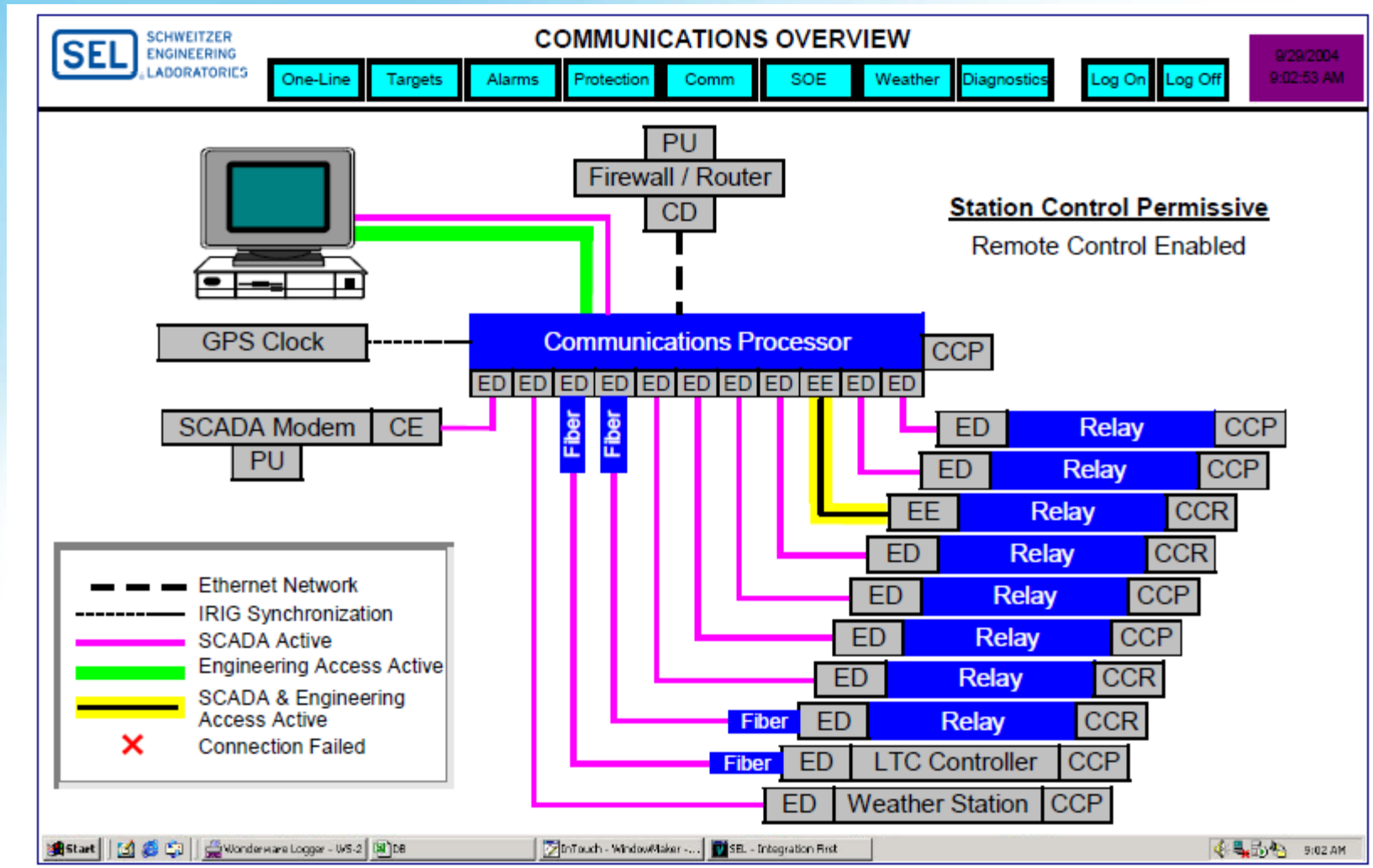
Smart Distribution Circuit Demonstrations

Distribution Domain Communications



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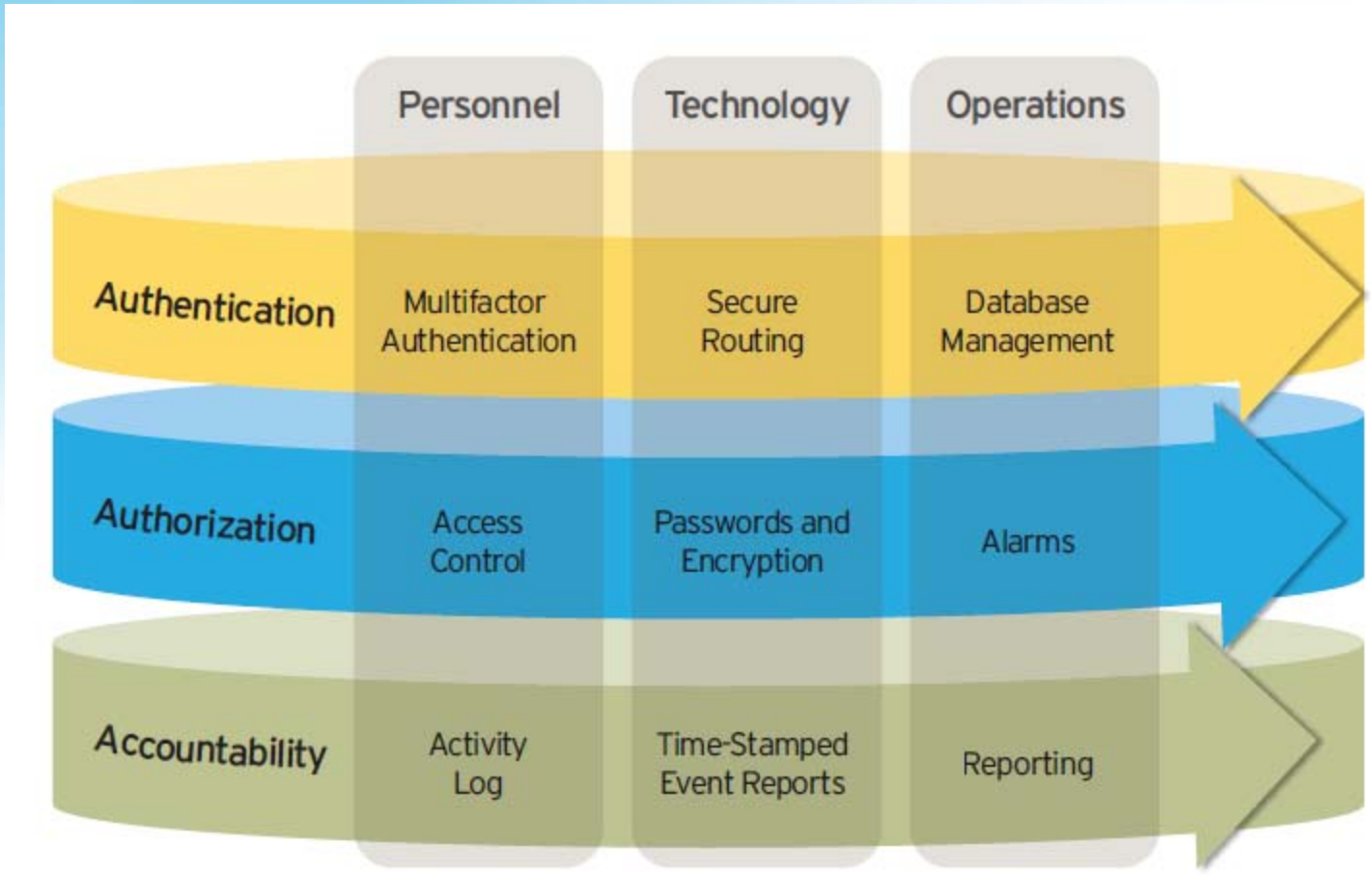
Smart Distribution Circuit Demonstrations

Cyber-Secure Hierarchy



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Smart Distribution Circuit Demonstrations
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Smart Distribution Circuit Demonstrations
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Phase	Duration
1 – Market Assessment, Technology Selection, Circuit Selection, Baselining	June 2015 – January 2016
2 – Circuit Scenarios, RTDS Modelling, Optimization of Circuit Operation	November 2015 – December 2016
3 – Evaluate Data, Recommend Best Practices, Project Documentation	November 2016 – October 2017

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